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PATENT



MARSP0173US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Cowley et al.

Serial No.: 10/643,125

Filed: August 18, 2003

For: RADIO FREQUENCY TUNER

Art Unit: 2681

Examiner: Edward F. Urban

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1345

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Attached please find the certified copy of the foreign application from which  
priority is claimed for this case:

Country: Great Britain  
Application Number: 0219785.3  
Filing Date: August 24, 2002

  
SIGNATURE OF ATTORNEY

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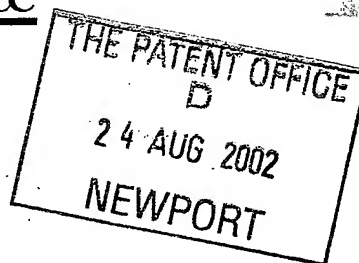
Dated

21 July 2003

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(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)



The Patent Office

Cardiff Road  
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1. Your reference

JSR.P52113GB

2. Patent application number

(The Patent Office will fill in this part)

0219785.3

24 AUG 2002

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Zarlink Semiconductor Limited  
Cheney Manor  
Swindon  
Wiltshire SN2 2QW

Patents ADP number (if you know it)

Britain

If the applicant is a corporate body, give the country/state of its incorporation

8242968001

4. Title of the invention

Radio Frequency Tuner

5. Name of your agent (if you have one)

Marks & Clerk

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

4220 Nash Court  
Oxford Business Park South  
Oxford OX4 2RU  
United Kingdom

7271125001

Patents ADP number (if you know it)

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)

Date of filing  
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

Yes

- a) any applicant named in part 3 is not an inventor, or
  - b) there is an inventor who is not named as an applicant, or
  - c) any named applicant is a corporate body.
- See note (d))

# Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	5
Claim(s)	2
Abstract	1
Drawing(s)	2

10. If you are also filing any of the following, state how many against each item.

## Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature

Date

Marks & Clerk

23 August 2002

12. Name and daytime telephone number of person to contact in the United Kingdom John S. Robinson - 01865 397900

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## RADIO FREQUENCY TUNER

The present invention relates to a radio frequency tuner. Such a tuner may be used, for example, as a digital tuner for interfacing between a multi-standard demodulator and a plurality of distribution media.

With increasing levels of integration offered by deep sub-micron processes, the level of integration offered in digital demodulators has greatly expanded. It is now technically feasible and cost-effective to integrate a plurality of demodulator blocks with associated MPEG decoders and a controller processor together with various interface circuitry for accessing the modulated data within a single integrated circuit. Such a demodulator arrangement could, for example, contain one or more demodulators capable of demodulating multi level QAM (quadrature amplitude modulation), QPSK (quadrature phase shift keying), COFDM (coded orthogonal frequency division multiplex), VSB (vestigial side band), or any combination thereof. Such an interface may be used for video encoding for pictures (for example in the case of DVBT/C/S), audio encoding for example in the case of audio services (such as DAB), or any number of data interface buses where the distribution media may be pure data (for example a cable modem).

In known arrangements, the interface between radio frequency (RF) distribution media and a base band processing circuit is provided by a plurality of different tuners, each supplying a different interface signal to the demodulator. For example, satellite signals are generally converted to zero intermediate frequency (IF) or base band quadrature components before analog-digital conversion. Conversely, digital terrestrial television (DTT) COFDM is generally converted to a non-zero IF and is further processed by IF amplifiers with interstage surface acoustic wave (SAW) filters, after which the composite signal is converted to the digital domain for demodulation. Such arrangements are cumbersome and do not provide a simple interface between the RF and digital domains. Instead, a plurality of tuners of different architecture are used with different interface means to, for example, a baseband chip containing all of the demodulation functions.

According to the invention, there is provided a radio frequency tuner comprising a first frequency changer for converting anyone of at least one first broadband signal in a first frequency range to a second higher frequency range, a first multiplexer for selecting any one of an output of the first frequency changer and at least one second broadband signal in the second frequency range, and a second frequency changer for converting to baseband any selected channel of the broadband signal selected by the multiplexer.

The frequency range of the frequency-converted at least one first broadband signal may overlap with the frequency range of the at least one second broadband signal.

The tuner may comprise a second multiplexer for selecting any one of a plurality of first broadband signals for conversion by the first frequency changer.

The second frequency changer may be a quadrature frequency changer.

The tuner may comprise a variable bandwidth filter for filtering the or each output signal of the second frequency changer. The or each filter may be a low pass filter.

The second frequency changer may have a tuning range at least as wide as the second frequency range.

The first frequency changer may have a relatively narrow tuning range. As an alternative, the first frequency changer may be arranged to perform a fixed frequency conversion.

The tuner may comprise a single monolithic integrated circuit.

It is thus possible to provide a single tuner architecture which can cater for many or all of the RF to digital interfacing, for example ahead of a demodulation arrangement capable of demodulating many or all types of modulation standards. For example, such an arrangement may be arranged to provide interfacing for any combination of digital audio broadcasting (DAB), digital terrestrial television (DTT), digital broadcast satellite



(DBS), and cable distribution. Such a tuner may provide a relatively simple interface to a demodulator function from a plurality of dissimilar frequency sources transmitted over dissimilar frequency ranges.

The invention will be further described, by way of example, with reference to the accompanying drawing, which is a block circuit diagram of a radio frequency tuner constituting an embodiment of the invention.

The tuner has a multiple input 1 which, in the example illustrated, is provided for DBS, L-band DAB, DTT and DAB in the VHF band. The DBS and L-band DAB inputs are connected via respective amplifier stages 2 and 3 which may provide an automatic gain control function, to a multiplexer (MUX) 6. The DTT and DAB VHF inputs are supplied via amplifier stages 12 and 13, which may also provide an automatic gain control function, to another multiplexer 14.

The output of the multiplexer 14 is supplied to a frequency changer comprising a mixer 4 and a local oscillator in the form of a voltage controlled oscillator (VCO) is controlled by a phase locked loop (PLL) frequency synthesiser 16. The output of the mixer 4 is supplied via another amplifier stage 5 to a further input of the multiplexer 6.

The output of the multiplexer 6 is supplied to a quadrature zero intermediate frequency or base band frequency changer comprising mixers 7 and a quadrature local oscillator 17 controlled by a PLL frequency synthesiser 18. The local oscillator comprises a VCO and a quadrature generator and band split arrangement. The PLL frequency synthesisers 16 and 18 may share common stages such as a bus interface and a reference divider.

The I and Q baseband signals from the mixers 7 are supplied via baseband amplifiers 8 to I and Q baseband filters 9. These filters, which may be embodied as low pass filters, have a variable frequency bandwidth which can be adjusted to cover all possible standards to be received. The outputs of the filters 9 are supplied to amplifier stages 10, which supply the I and Q output signals to the tuner outputs 11.

Any one input at a time may be selected by suitably controlling the multiplexers 6 and 14. The first frequency changer performs an up-conversion, which may be a fixed frequency conversion or which may be tunable over a narrow range, for example so as to avoid undesirable effects of beating between the oscillator harmonics. The first frequency changer thus performs a block up-conversion of the broadband signal selected by the multiplexer 14. This conversion is to a frequency range which substantially overlaps the frequency ranges of broadband signals supplied directly to the multiplexer 6.

The frequency strategy is such as to avoid harmonic mixing effects. In a typical application, the broadcast terrestrial band (from the multiplex 14) covers a frequency range from 50 to 860 MHz. If a quadrature downconverter were applied directly, then for frequencies up to  $860/3$  the third harmonic frequency of the oscillator would lie within the received band. As a consequence, unless band split filtering were applied in front of the mixer, the channel corresponding to the third harmonic would also be downconverted to baseband and so appear as a distortion signal on the desired channel. A similar distortion effect would occur from other odd harmonics of the local oscillator.

The tuner shown in the drawing overcomes this effect without the requirement for band split filters since the first upconversion frequency changer (4, 15, 16) utilises an oscillator frequency above the broadcast band hence there are no channels within the desired band which will correspond to harmonics of the local oscillator. The quadrature downconversion to zero IF output typically downconverts in the frequency region of any channel 1-2 GHz. Again, the third harmonic of the local oscillator will lie outside of either the received or block upconverted frequency band.

An example frequency strategy may be as follows

Terrestrial (50-860 MHz)	mixer (LO @ 1.1 GHz)	Upconverted terrestrial (1.15 – 1.96 GHz)
		Common overlapping band
Satellite (950-2150 MHz)	Ina	(0.95 – 2.15 GHz)

In a typical example of a frequency strategy, the frequency of the VCO 15 is set to 1.1 GHz so that the terrestrial band is block upconverted from 50-860 MHz to 1.15-1.96 MHz. The satellite band is 950-2150 MHz and contains the upconverted terrestrial band. The VCO 17 is tunable over the range 950-2150 MHz (0.95-2.15 GHz) so as to convert any received channel to baseband.

Channel selection is performed exclusively or substantially exclusively by the second frequency changer. The second frequency changer is therefore tunable over a range of frequencies which covers all of the channel frequencies which may be output by the multiplexer 6. In order to avoid interfering artefacts, the frequencies of both the frequency changers may be offset slightly.

It is thus possible to provide a single architecture for a tuner such that it is capable of receiving and converting to baseband anyone of a plurality of different input signals in different frequency ranges and with different modulation standards. Automatic gain control strategies and baseband filtering parameters may be selected in accordance with the modulation standard of the broadband input signal currently selected by the multiplexers 6 and 14. A very high degree of integration may be achieved and it is possible to integrate the whole tuner as a single monolithically integrated circuit. A single RF interface may therefore be provided ahead of a multi-standard single chip demodulation arrangement.

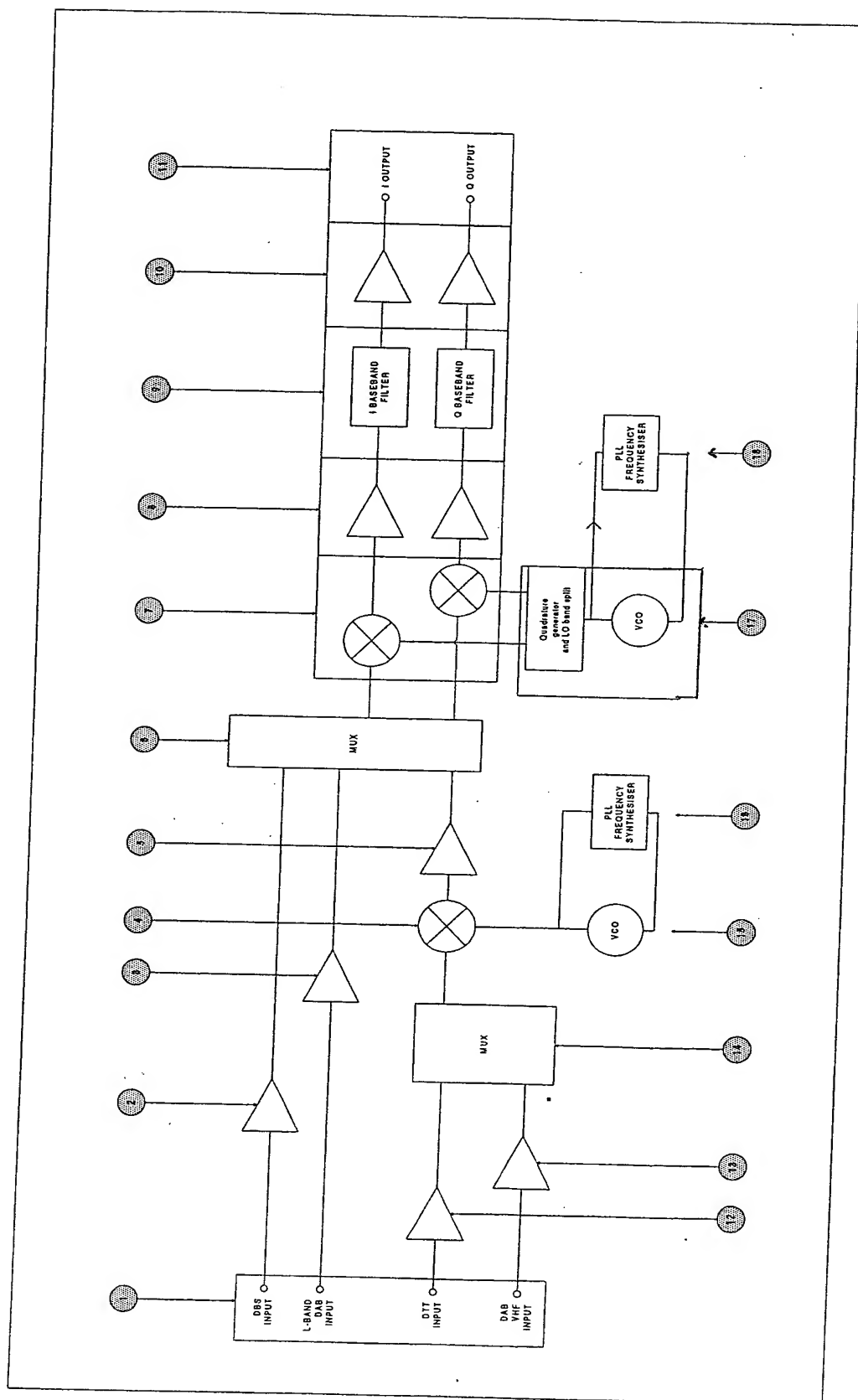
**CLAIMS:**

1. A radio frequency tuner comprising a first frequency changer for converting any one of at least one first broadband signal in a first frequency range to a second higher frequency range, a first multiplexer for selecting any one of an output of the first frequency changer and at least one second broadband signal in the second frequency range, and a second frequency changer for converting to baseband any selected channel of the broadband signal selected by the multiplexer.
2. A tuner as claimed in claim 1, in which the frequency range of the frequency-converted at least one first broadband signal overlaps with the frequency range of the at least one second broadband signal.
3. A tuner as claimed in claim 1 or 2, comprising a second multiplexer for selecting any one of a plurality of first broadband signals for conversion by the first frequency changer.
4. A tuner as claimed in any one of the preceding claims, in which the second frequency changer is a quadrature frequency changer.
5. A tuner as claimed in any one of the preceding claims, comprising a variable bandwidth filter for filtering the or each output signal of the second frequency changer.
6. A tuner as claimed in claim 5, in which the or each filter is a low pass filter.
7. A tuner as claimed in any one of the preceding claims, in which the second frequency changer has a tuning range at least as wide as the second frequency range.
8. A tuner as claimed in any one of the preceding claims, in which the first frequency changer has a relatively narrow tuning range.

9. A tuner as claimed in any one of claims 1 to 7, in which the first frequency changer is arranged to perform a fixed frequency conversion.
10. A tuner as claimed in any one of the preceding claims, comprising a single monolithic integrated circuit.

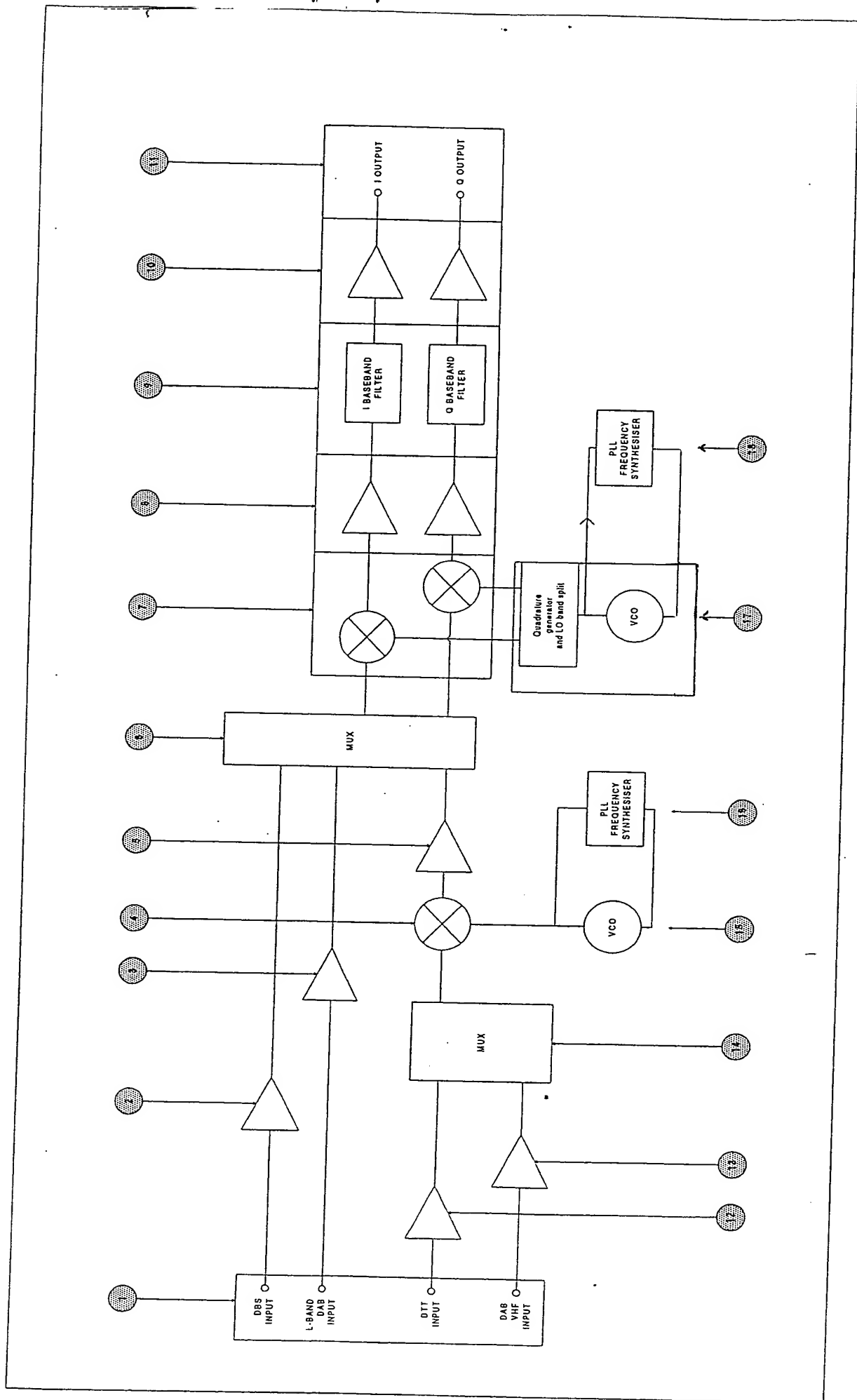
**ABSTRACT**  
**RADIO FREQUENCY TUNER**

A radio frequency tuner comprises a first frequency changer (4, 15, 16) for converting an input broadband signal in a first frequency range to a higher second frequency range. A multiplexer (6) selects between the output of the first frequency changer (4, 15, 16) and anyone of second broadband signals in the second frequency range. A second frequency changer (7, 17, 18) converts to I and Q baseband signals any selected channel in the broadband signal from the multiplexer (6).



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